UNIVERSITY OF LATVIA

Visible-NIR Multispectral Imaging of Whole-Body Human Skin

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NBC-20, Warsaw (PL), 17/06/2025

Whole-body skin imaging

← Multi-camera design

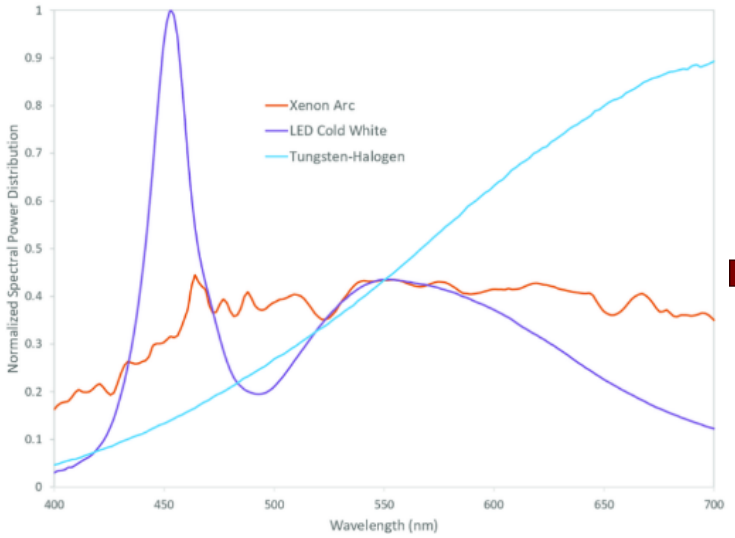
Single camera design →

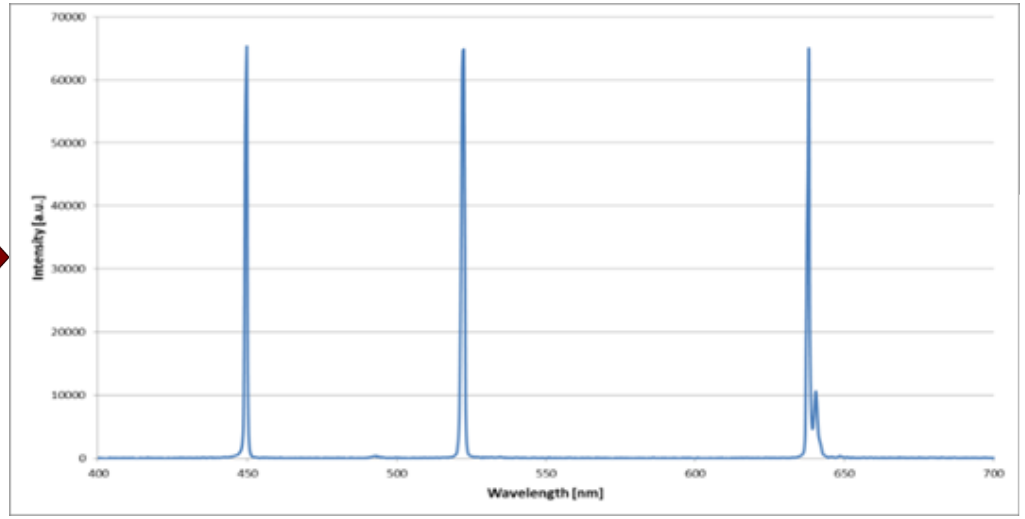
Fotofinder ATBM master 4th Gen

Canfield Vectra WB360 3D

This study:
broadband white illumination replaced by multi-laser line illumination → extracting sets of **narrowband spectral skin images** in the visible and near-infrared ranges for improved diagnostics

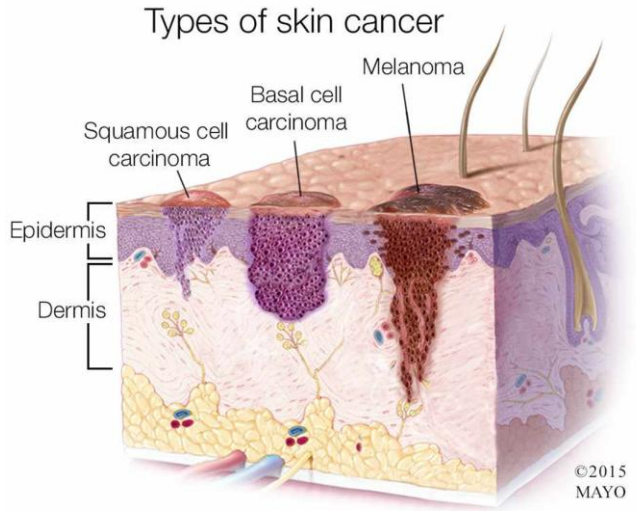
The main idea

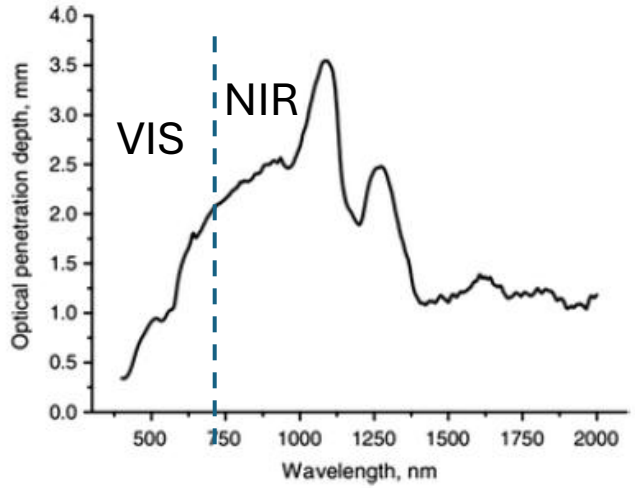




White broadband illumination: halogen lamp, LED or Xe lamp

Combined spectral lines: 450nm, 520nm, 638nm (VIS), + 850nm, 940nm (NIR)
→ subsequent extraction of skin spectral images at these wavelengths

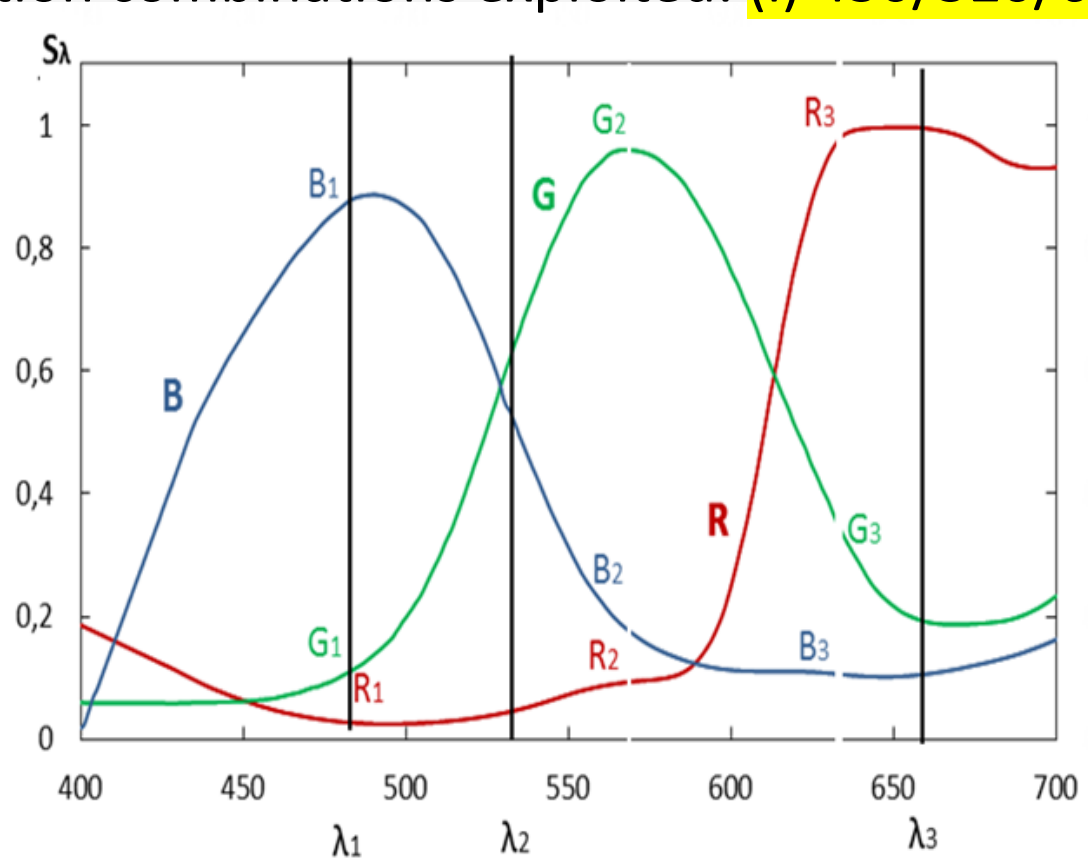


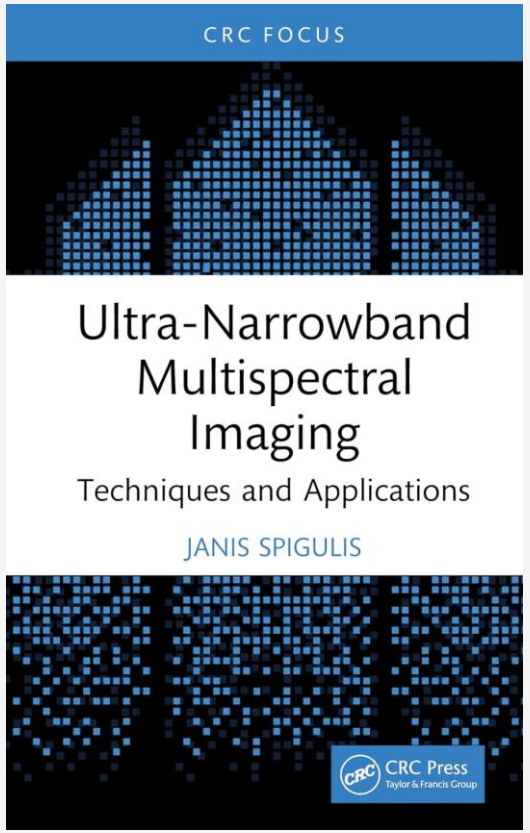


Skin penetration/imaging depth increases with wavelength up to ~1100 nm

Extraction of 3 spectral images at triple laser line illumination

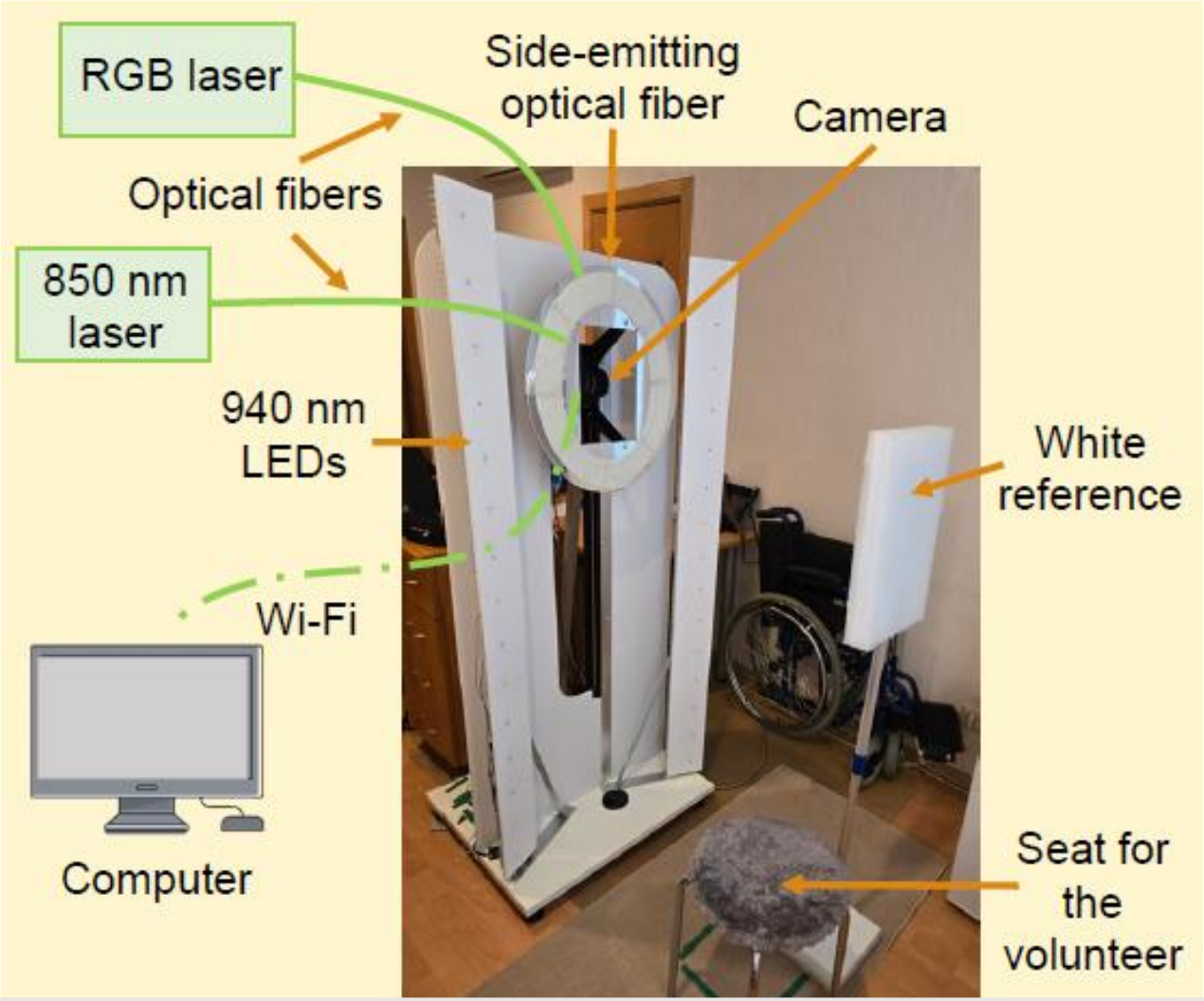
- Three spectral images, each related to one specific wavelength, can be extracted from a single-snapshot image data. Conditions: the relative sensitivities of photo-detector at all three illumination wavelengths are known and the photo-response is linear (Proc.SPIE, 2014)
- Illumination combinations exploited: (i) 450/520/638nm; (ii) 450/520/850nm; (iii) only 940nm

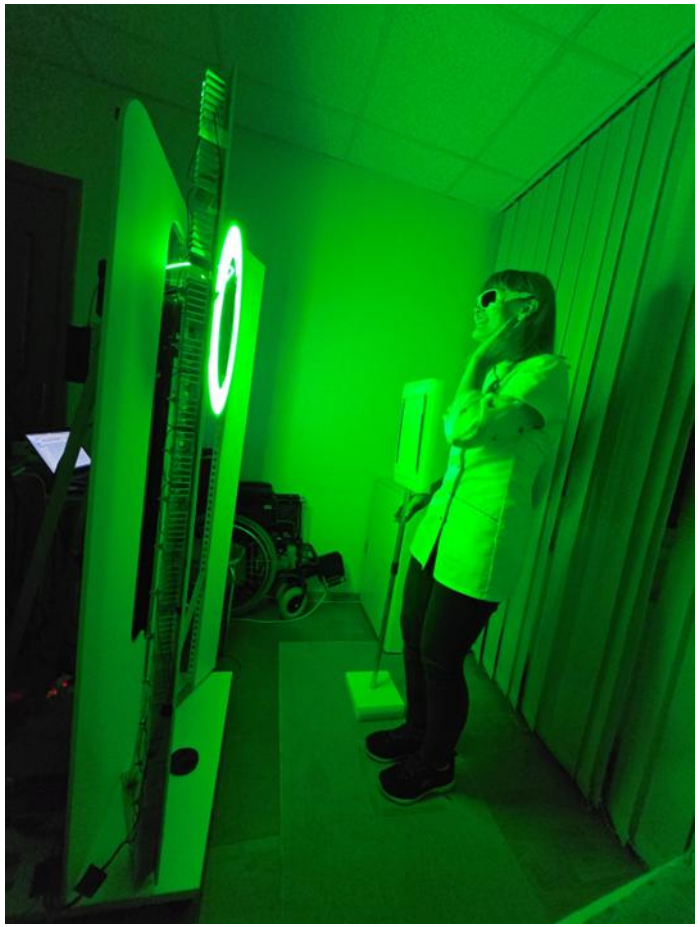




J.Spigulis, L.Elste. Single-snapshot RGB multispectral imaging at fixed wavelengths: proof of concept. *Proc.SPIE*, 8937, 89370L (2014).

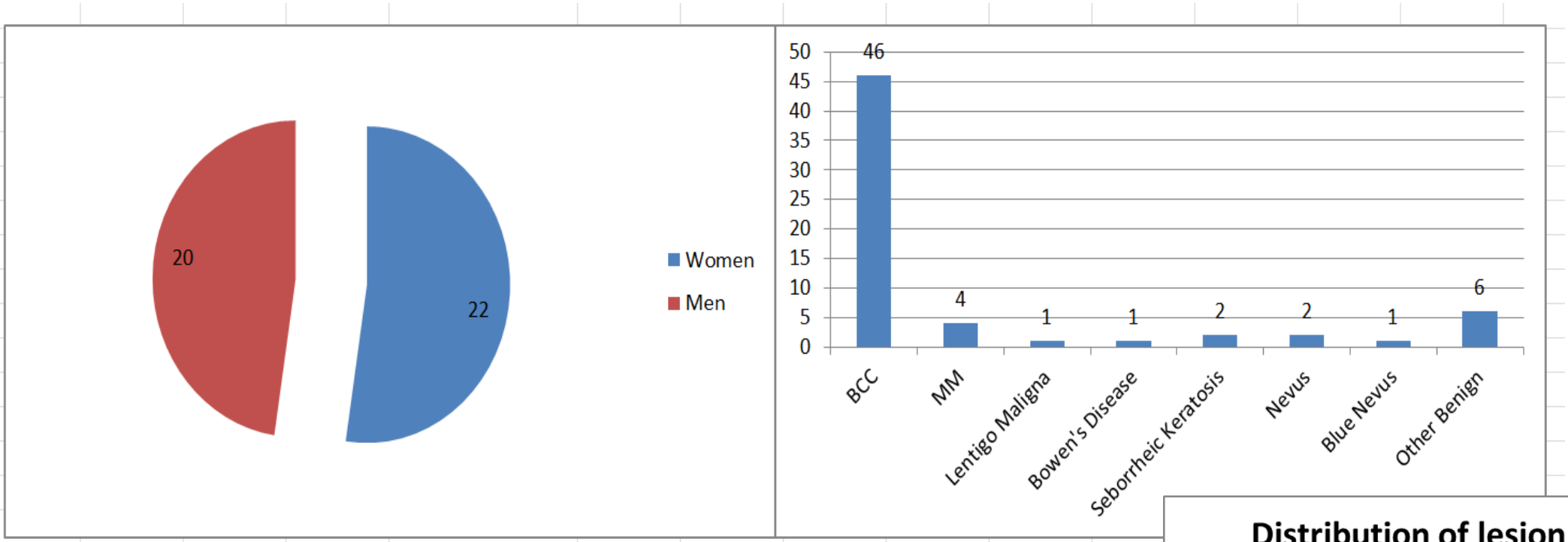
Equipment: prototype system

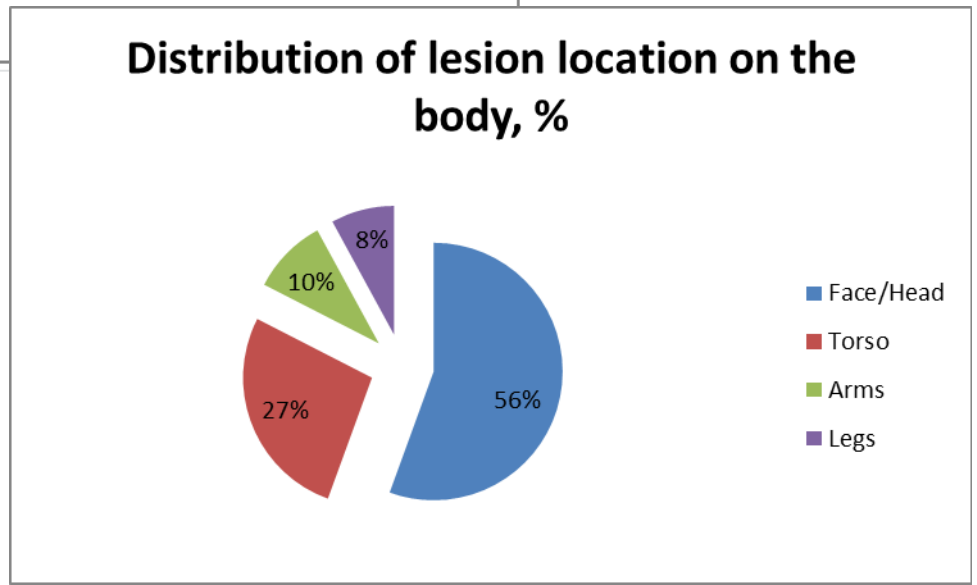




61-megapixel color camera (Sony a7R IVA), NIR filter removed
Side-emitting optical fiber spirals: 60 m (RGB laser) and 30m (850nm laser)
3 x 1 W RGB laser with SMA output, 450/520/638 nm + 1W 850nm + 940nm LED set
Camera & illuminator up-down movements (0.5m - 1.5 m)
Placed in a light-shielding tent or in a dark room (Latvian Oncology Center patient measurements)

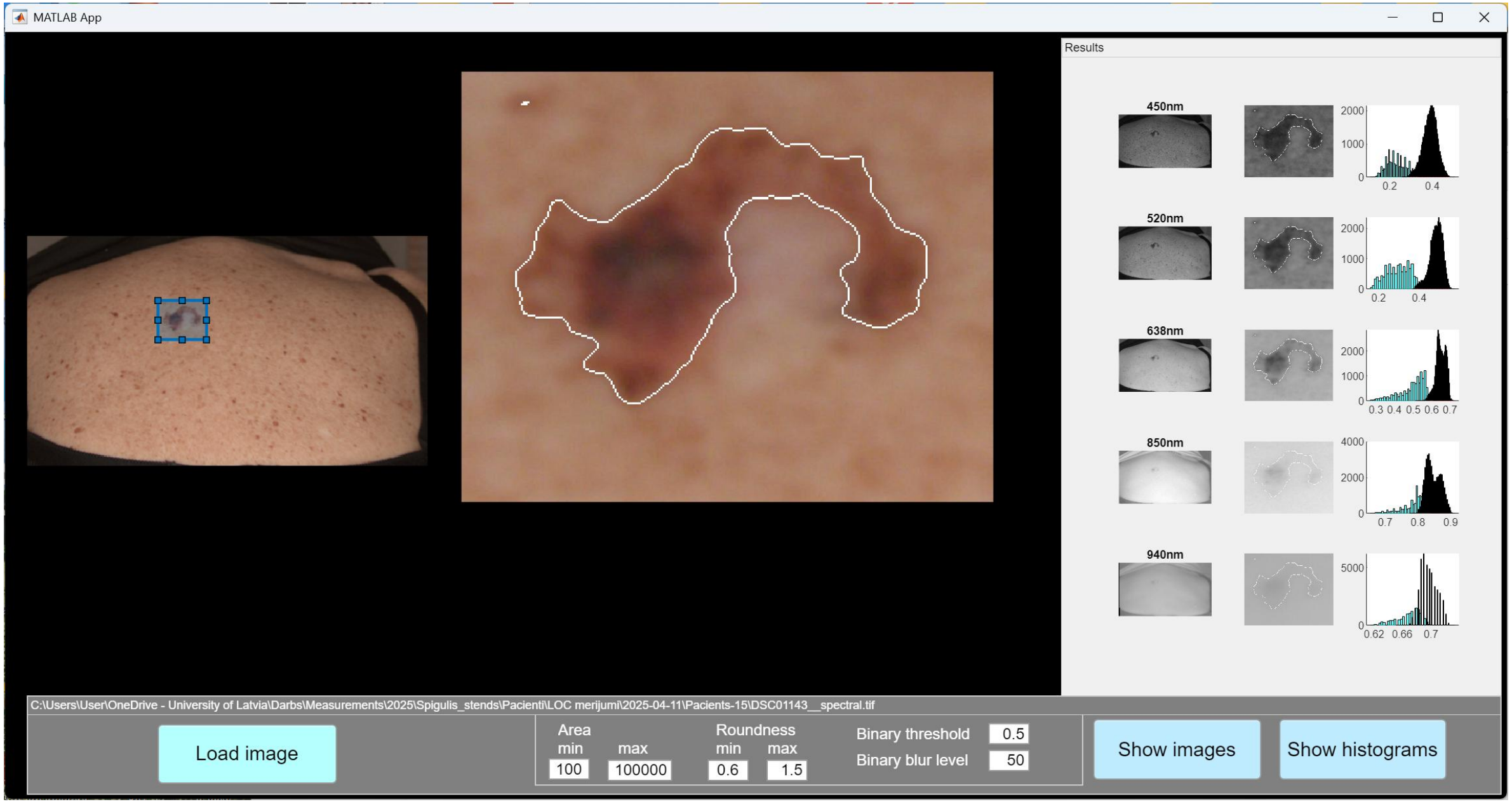
Clinical study in LOC: 42 patients, 63 malformations



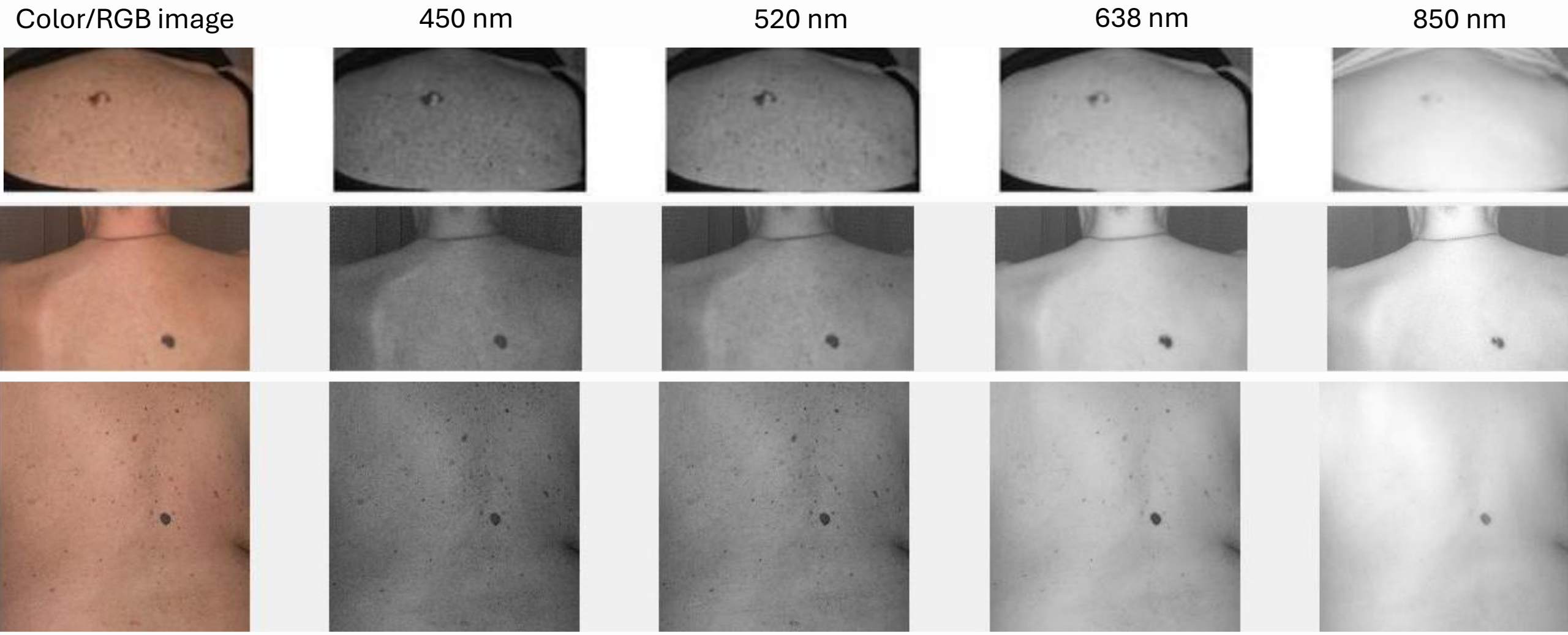


Previous research:
J.Spigulis, U.Rubins, E.Kviesis-Kipge, I.Saknite, I.Oshina, E.Vasilisina, **"Triple spectral line imaging of whole-body human skin: equipment, image processing, and clinical data"**, *Sensors* **24**, 7348 (2024). DOI:10.3390/s24227348.

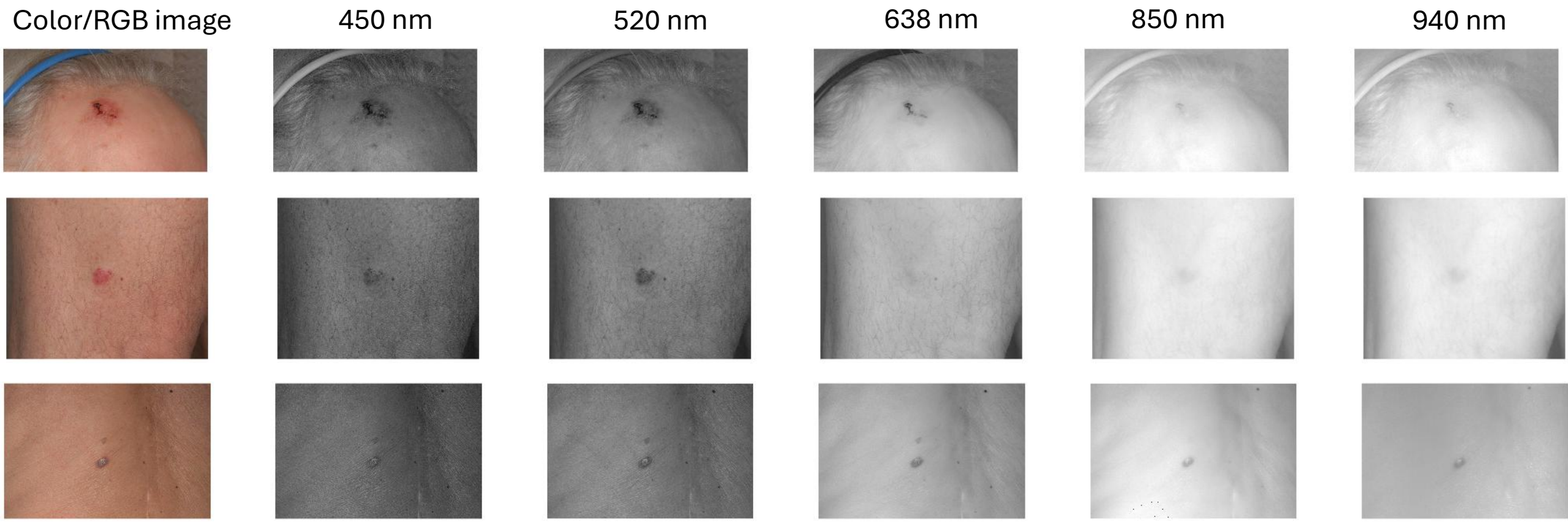
The image processing tool



Examples of clinical spectral images: MM on the back skin



Examples of clinical spectral images: BCC (basalioma)

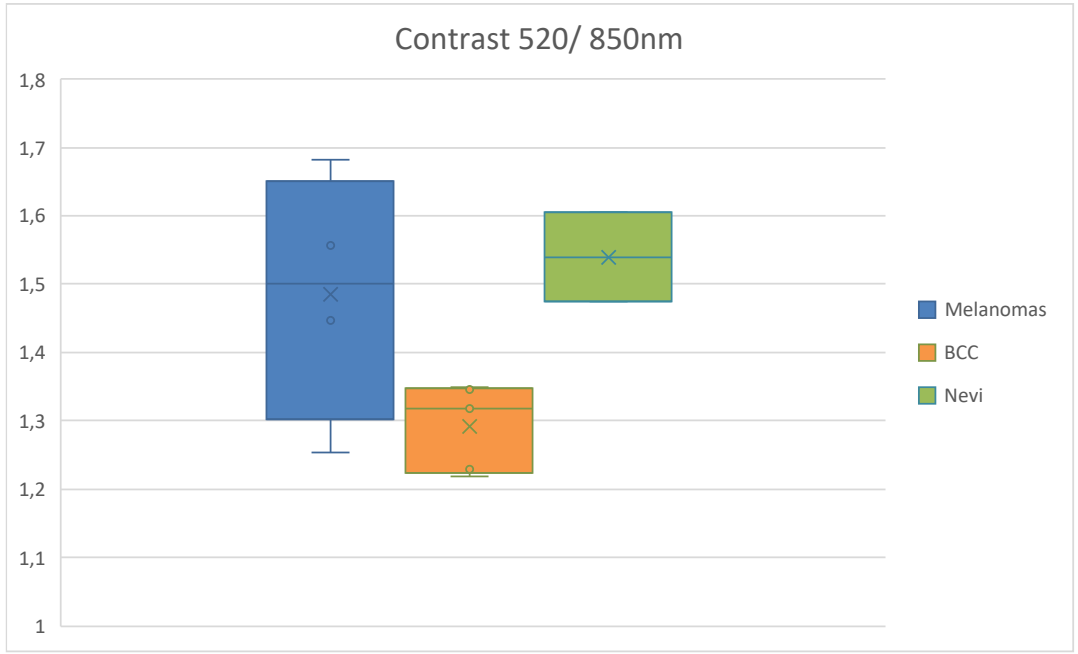


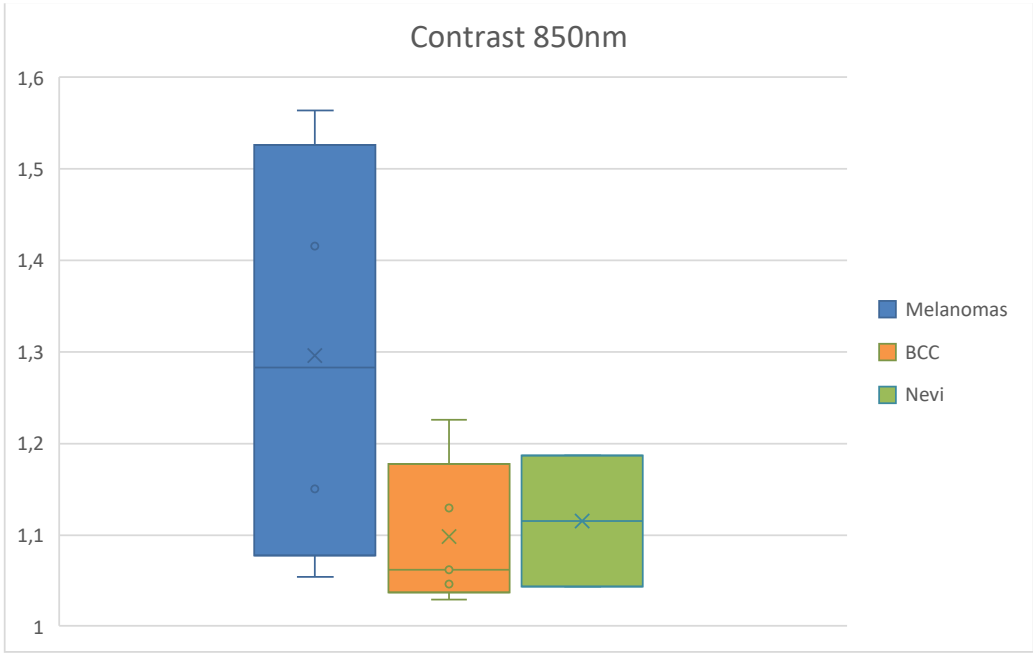
Provisional results: contrasts in malformation's spectral images

$$\text{Contrast} = I_{median\_skin} / I_{median\_malf}$$

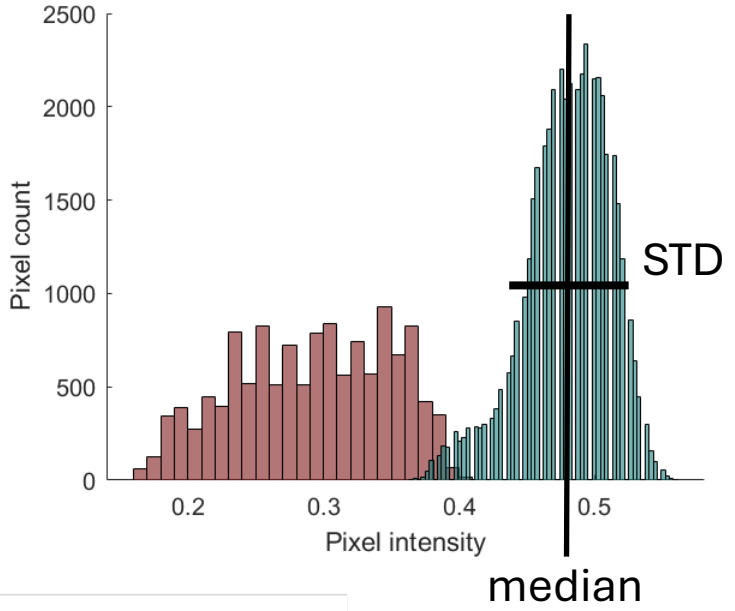
$I_{\_median\_skin}$ - median pixel value of surrounding skin

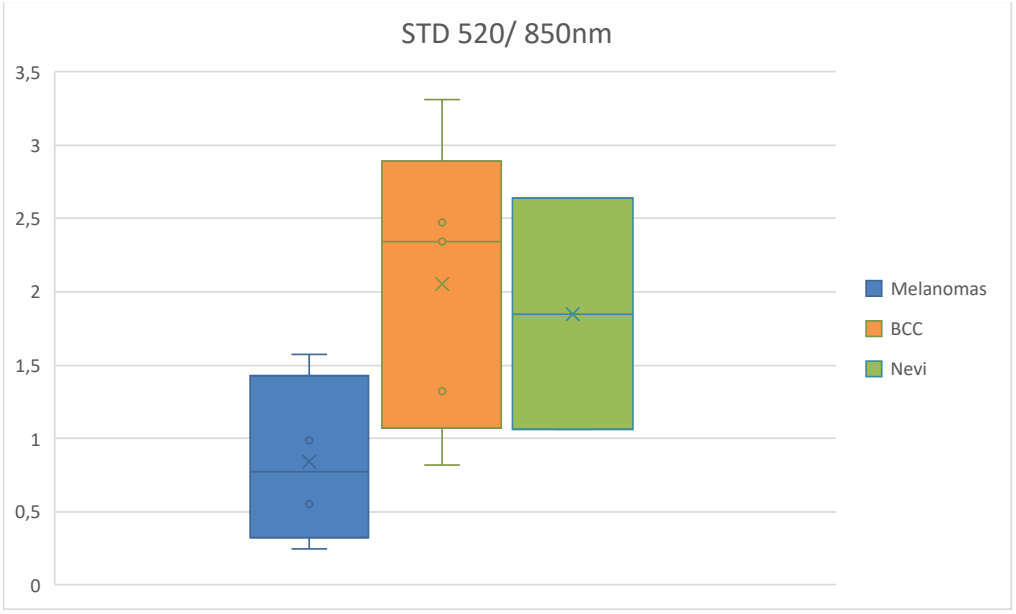
$I_{\_median\_malf}$ - median pixel value of malformation





Provisional results: standard deviations in histograms of spectral images





Summary

- A prototype system for multispectral imaging of full-body skin at five VIS-NIR wavelengths (450/520/638/850/940 nm) was assembled and clinically tested
- 63 skin malformations were examined in Latvian Oncology Center, including 50 malignant tumors - 4 melanomas and 46 basal cell carcinomas
- General trend: most skin malignancies are still visible in NIR spectral images, while nevi and other benign malformations fade/disappear. Could be helpful for fast early screening of skin melanoma.
- Potential diagnostic criteria for MM, BCC and nevi: contrasts and histogram standard deviations yielded from NIR spectral images, or their ratio to those at visible wavelengths (e.g. 520nm/850nm)
- More patient data should be collected, our clinical study continues

Acknowledgments

This research is funded by the Recovery and Resilience Facility project "Internal and External Consolidation of the University of Latvia" (No.5.2.1.1.i.0/2/24/I/CFLA/007), grant No. LU-BA-PA-2024/1-0006.

Funded by
the European Union
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Thank You!

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